Wageningen Food & Biobased Research | whitepaper

Amsterdam Challenges for Circular Designs

A lead question for the circular bio-economy is a simple one: how can we accelerate transition, and put our circular 'dreams' into practice? And, how to do this within the city context? When redesigning for circularity on a city level, all aspects need to be taken into account, governance, technologies, stakeholders, social behaviours and markets. We need to change together and utilizing the city scale to optimally value our precious resources and finding new ways to use bioresources in the urban environment. 'By design' indicates that something is intentional. It does not happen spontaneously, and it cannot be left to its own devises. This process of designing for circularity has been applied within the Amsterdam area, showcasing four city 'challenges' as inspiration that it can be done!

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Acknowledgement: this whitepaper is based on the findings of the Circularity by Design Flagship Project of Wageningen University & Research in collaboration with the AMS Institute (2019-2022, KB-40-004-001), and funded by the Ministry of Agriculture, Nature and Food Quality. Main contact person on behalf of the project team is Hilke Bos-Brouwers. A special thank you for team members Aranka Dijkstra, Willie van den Broek, Alexander Laarman and Leendert Verhoef from AMS Institute for their coordinating role in the Amsterdam Challenges.

PLEASE CLICK ON THE SECTION OF YOUR CHOICE

A circularity-by-design approach

Circularity by Design (CbD) aims to arrive at better designs than the current linear practice. Working with AMS Institute and Challenge Owners from the Amsterdam Metropolitan Area (AMA), we constructed tools to support cities, municipalities and regions in their transition towards a circular bio-economy. Our results inform and encourage stakeholders at the urban and regional levels across the globe to take this CbD approach and use them as design principles for their own context. The CbD approach consists of four steps:

Step 1: Taking inventory of supply and demand
The scope of what one person sees is limited, and it bears pointing out that a person does not know what he or she does not know: Combining insights into collaborative knowledge brings insights to the table and creates a common knowledge base. While you are gaining a clearer picture about the demands and supplies regarding resources needs and functions, you will also learn about uncertainties, gaps and disagreements. Only when these wrinkles are front and centre will you be able to work with and around them. To support this inventory step, we have created a circular bio-economy database for by-products within AMA as an example. It is not easy to collect data with sufficient quality, but improvements can be made: The data are meant to help establish ambition levels and also to be able to determine what consequences opportunities or design choices have.

Step 2: Assessing the scope of opportunities
You also need options: what techniques, concepts or solutions can help to create your circular design? What is readily available, and what would be interesting to pursue? A resource-oriented question such as 'What can you do with elephant manure?' can be a good starting point, but also good starting points might be the creation of a circular communal living site or the redevelopment of a whole high-rise neighbourhood. Cities are neither built in a day or built for only a day—the expectation is that they last a lifetime, or even centuries! Options do not necessarily need to be fancy or high-tech: they need to point towards what will become the *new normal* on how to circulate agri-food resources within the city.

Step 3: Making design choices
Resources can be allocated for very different uses, such as for food, feed, bio-materials or improving soil in neighbouring farms. Matching demands with options requires answering questions such as 'What will be the best choice for the specific challenge?' and 'How can I compare different options?' Each option will have a different 'scorecard' with regards to socio-economic and environmental indicators, allowing to prioritise options. We have delivered a set of tools that provide users with a 'one-glance' overview of different valorisation strategies and help for making choices that fit the context and ambitions of stakeholders involved.

Step 4: Circular design
The previous three steps do not necessarily follow a chronological order: circumstances and people involved can change during the design process, in which case it is beneficial to retrace your steps and adjust where needed. The example challenges from the 'Circularity by Design' project function as inspiration and demonstrate that it can be done. They vary in terms of both magnitude and ambition. This is inherent to the design process: priorities vary, and that is fine with us. Besides, we would like to continue exploring!

The CbD approach therefore proposes a circular bio-economy that utilises a food systems perspective to map all resource flows, benefits, and burdens of our current agri-food and waste system in the AMA city-region, as well as the governance structures and policy levers that keep this system in place, and have the potential to change it. Importantly, our CbD approach proposes to capture not only environmental and economic impacts, but also social impacts in the AMA city-region, including for example quality of life, social inclusion, food security, and transitions potential.

The CbD approach takes a geographic, sectoral, and sustainability perspective on circularity, to ensure that not only are materials reused – but that they find their highest and best use in the local food economy. For example, surplus food is redistributed to people rather than bio-digesters, organic waste is composted or converted to animal feed rather being burned for home heating or converted to jet fuel.

The Amsterdam Challenges

The Challenges are real-life cases where food circularity is being developed or can be incorporated. These Challenges form the test ground for researchers to design their solutions or to design experiments which will help towards these solutions. The Challenges should help sharpen and validate the concepts from the CbD approach. Ideally, the Challenges serve as examples for future Circularity research and experimentation.

To connect science to the city and vice versa, the Living Lab approach is used, for it is a way to speed up the transition to a more circular society. By involving all stakeholders the gap is bridged between policy, science and citizens. A living lab environment will make it feasible to validate and implement circular experimentation methodologies, tools and platforms to help stakeholders (students, scientists, citizens, companies, and cities) to do reliable and scalable experiments to solve and create impact within the urban environment.

The role of AMS Institute in this project was to identify candidate urban challenges that have the potential to become a living lab. The first step for AMS Institute is to stimulate Challenge 'owners' to dream about desired outcomes for their challenge and challenge researchers to design experiments that can contribute to reach the challenge dream. Together, these experiments have to be organized in such a way, that a shared vision for this future dream can be constructed. The next step is to project these experiments on the specific urban challenge context and extract the boundary conditions for the local experimentation space: the living lab conditions. These conditions decide whether the designed Living Lab is able to reach the challenge dream or not. AMS Institute has identified 4 potential urban challenges to be assessed for Living Lab suitability.

Four challenges have been adopted within the project, including

1. Circular Food Services, by Artis
2. Circular Household Organic Waste, by the Municipality of Amsterdam
3. Circular Way of Living, by Urban Tree Village
4. Circular Neighbourhood, by BKO/Green Tower Bijlmer Kwartier

All Challenge Owners have provided formal commitment on forehand to join this journey. A joined Project Start UP (PSU) was organized where each challenge holder could describe its dream, and where they also connected with the CbD project's focal points of Food, Feed, Biomaterials and Waste management.

Circular Food Services

The joint PSU resulted in a canvas description for the ARTIS challenge, from the dream of achieving a zero waste catering on the zoo's premises. The first finding was that not only zero waste catering was part of the dream, but also zero waste water. Drinking water costs in Amsterdam are high (around 1 €/m^3 in 2020) but water disposal via the local sewage system is even more expensive (2 €/m^3). Therefore, circular use and reuse of all water functions at ARTIS must be included in the dream.

Here, the main activities focus on the design of a circular water system where different water sources (tap water, rain water, canal water, storage water, ground water, waste water (grey and black)) can be treated with nature-inclusive technologies to a quality where it can be reused for other water functions (like pond filling, flora & fauna maintenance, toilets, fountains, animal habitats (fish), cleaning activities etc.). Also the remaining residuals (organic materials and nutrients), extracted from the water need to be reused.

For the zero waste catering concept, a Living Lab proposal for the MADE students that are associated with AMS Institute has been prepared for the new to build ARTIS food boulevard. The aim of this proposal is: how to design a zero waste food boulevard for this specific location and include the local neighborhood if balancing of (waste) volumes is needed. Based on a stakeholder workshop, including WUR expertise on food waste within catering, a Zero Waste restaurant proposal have been developed (see figure 1).

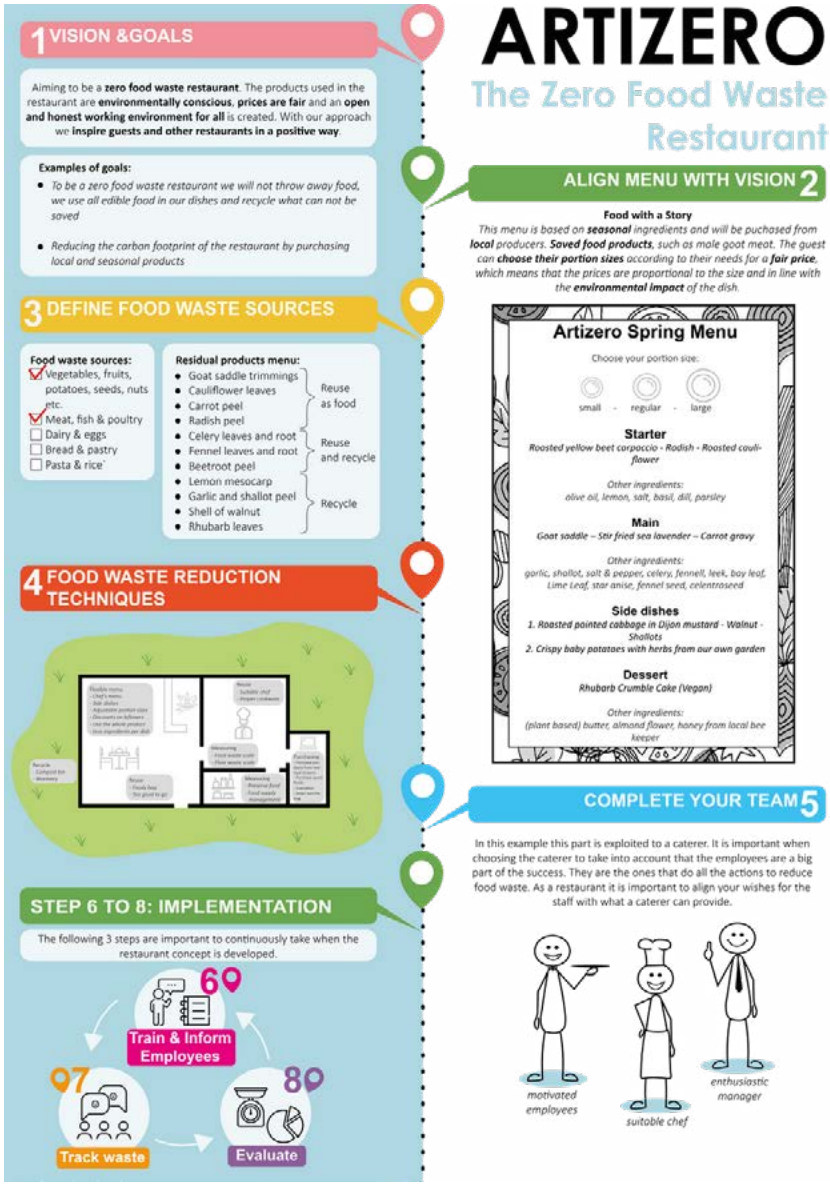

Figure 1 Artis Zero Food Waste Restaurant

Another venue for zero waste catering, while optimising the available bioresources of the zoo, is the experiment to grow oyster mushroom on elephant manure. This experiment was co-developed by Upzwam, WUR, Artis and AMS Institute, also receiving additional funding from the municipality of Amsterdam ('Subsidieregeling Ruimte voor Duurzaam Initiatief').

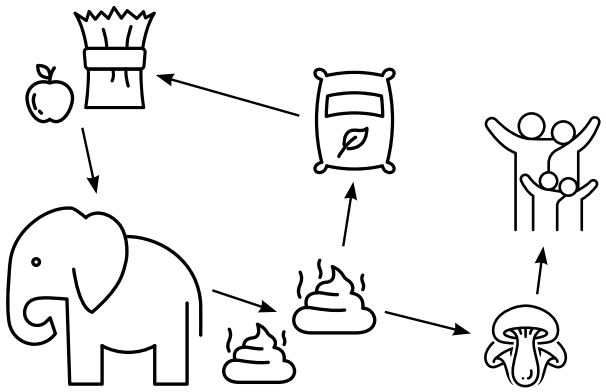

Figure 2 Overview of elephant manure upgrading through mushroom production

At current, the elephant manure is transported (by Nijssen Fourages B.V.) to an external location (Kranenburg) and composted into a fertilizer for agriculture. The stream is officially labelled as 'animal manure' (Eural code 02 01 06: animal faeces, urine and manure (including used straw), wastewater, separately collected and processed elsewhere). A total of 500,000 kg of waste is released at Artis (of which elephant manure thus is a fifth). The idea consists of upgrading elephant manure into oyster mushrooms and fertilizer (SMS, spent mushroom substrate or, in Dutch, champost). In this way disposal costs could be decreased and extra revenues could be generated by processing the mushrooms in Artis' restaurant e.g. into snacks or soup. Upzwam was approached for producing the mushrooms. The mushrooms could be marketed by wholesaler Sligro via catering company Vermaat. Based on a composition analysis of sampled manure, different types of mushrooms (mushrooms, oyster mushrooms) can potentially be grown on elephant manure (regular substrates often contain manure and/or are high in fibre). Oyster mushrooms were chosen (*Pleurotus ostreatus*) To make elephant manure suitable, a number of steps could be needed including hygienisation. Upzwam trialled the production of the oyster mushrooms, and samples were send to Eurofins Food, Feed & Water Testing Netherlands and tested for contaminants. None were found. Based on the process described in this report growing oyster mushrooms on elephant manure can be a good example of circular food production/upcycling of residueal streams. The mushroom yields were substantial and no food pathogens, pesticides or heavy metals were detected that could hinder sale of the mushrooms. A local network can be setup in which Upzwam produces oyster mushrooms on Artis' elephant manure and the mushrooms can be marketed locally at Artis or other local retailers. In addition, setting up a production system can have an educational function for Artis visitors, as they can directly 'taste' circularity in practice.

Figure 3 Oyster mushrooms produced on elephant manure by Upzwam

Circular Household Organic Waste

The joint PSU resulted in a canvas description for the Grinder challenge and the observation that a separation of short term and long term activities was needed. The challenge holder is aiming for a viable business case in the short term, where short term is defined as being able to reach TRL level 8 within 3 years. Further mentioned as the commercial pathway of the challenge. On the contrary, the CbD-team is aiming for innovations in the long term: being able to reach TRL level 8, beyond 3 years. Further mentioned as the innovation pathway of the challenge. The aim of the long term activities is to advise on separation technology and on possible valorization for the different fractions. The advice consists of technology specifications (type of separation, equipment properties and requirements, indicative costs, possible suppliers) and options for use of the fractions (volumes in time, properties, possible valorization). The resulting advice serves as input for future improvements of the design of the waste collection and processing unit for high rise buildings. The waste stream of interest is household food waste as typical for an apartment building. The food waste is collected with a kitchen grinder and possibly diluted with water to facilitate transport through the building. Research on the valorization options includes a view on volumes in relation to transport and other logistic aspects. The first activity was to connect both the commercial and innovation pathways. This was done by A&G to invite AMS Institute and 3 CbD experts to join the advisory board of the commercial pathway. In this way, CbD experts kept informed about the developments in the commercial pathway and will be able to incorporate these findings in their design for the innovation pathway. Based on the Living Lab canvas, the CbD team was able to develop a first design for source separation of the grinded kitchen waste.

Another result of the Living Lab canvas was the observation that kitchen waste is not allowed by law to be reused in the feed or food supply chain. This prevents kitchen waste to be reused as high quality feed or food and therefore make the grinder-business case more robust. One of the reasons for this prohibition is the possible presence of animal meat in kitchen waste, which is by law forbidden to feed to the same animals. To further investigate the opportunities, AMS Institute joined a Topsector PPS consortium on Safe insect cultivation on yet to be legally authorised residual streams (LWV20102).

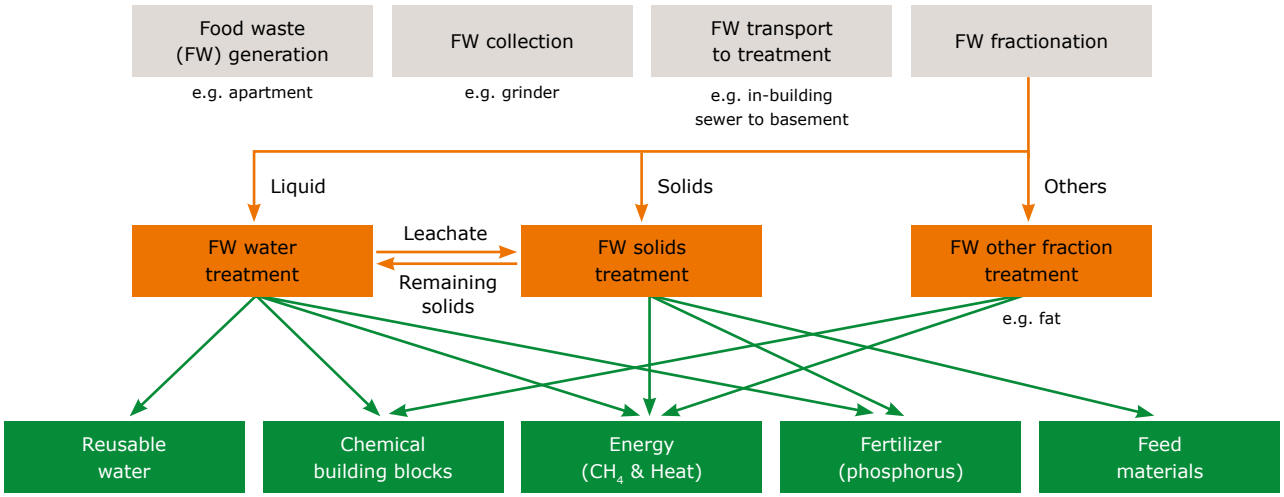

Figure 4 Source-separation FW solutions: Design framework

Circular way of living

There have been several workshops with Urban Tree Village, AMS Institute and WUR, to discuss the development of new city communities based on circular ways of living. Due to the lack of a physical location of the challenge, making it difficult for experimentations, a new concept has been provided by UTV. This is called the "Urban food garden". Basically the idea is to set up a concept to mimic the food production system on the future UTV site. This food production system is a greenhouse fully integrated within the urban context using resources from household waste and producing products (seedlings, vegetables and herbs and services (horeca, out of home, education) for food production and consumption. The potential location to set up this concept is Marineterrein and together with Marineterrein team the discussion has started.

Circular neighbourhood

BKO is a consortium of AM, AT Capital invest and Cairn responsible for the development of the Bijlmer Bajes district in Amsterdam, including the Green Tower; BKO has a commitment to the municipality of Amsterdam that the Bajes district will become a healthy, sustainable and inclusive neighbourhood in the field of water, energy, food, waste, health, mobility and circularity. The Green Tower promises to be an objectification of the integration of all the above topics with a highly innovative appearance and must attract residents, citizens, tourists, educational institutions and companies; The Green Tower will be developed in several stages over the course of the coming 5-7 years. Within the context of the CbD project, a partnership between BKO and AMS Institute was developed to create the Green Tower Living Lab, in collaboration with WUR and TU Delft. The Living Lab can be seen as a platform/entity that allows testing of new innovations and approaches on sustainable urban planning before upscaling them to other locations in the wider metropolitan area of Amsterdam. Next to food/ bioresources, the Green Tower Living Lab also includes issues such as mobility, energy, building etc. in an integrative manner. Regarding circular bioeconomy, items such as urban food production, healthy food for

consumers, innovative waste management options and valorising resources and nutrients from food and other organic wastes. The Green Tower will become a place where neighbours of the Bijlmer Bajes district can recreate on a daily basis, as well as a site where the platform welcomes 60-80.000 visitors annually to educate on sustainable urban planning and development. The Green Tower Living Lab offers experimental space for developing proposals and ideas, learning by doing approach by implementing test cases, connecting with researchers from TU Delft and WUR, accessing stakeholder networks of companies, municipalities, developers, building companies etc. for implementing innovations, community building between practitioners and researchers, 'showroom' of experiments for visitors, etc. Experiments that are suitable for the Living Lab are characterise by the availability of a minimal viable product, proof of concept approaches, demonstration projects and market replication studies. The way of working of the Living Lab has been established as follows:

Step 1: Initiation: from orientation to idea formation (scouting)
It all starts with a need, a problem, a challenge, etc. These can be collected from the networks of BKO and AMS Institute and formed into experiment ideas that could fit the Living Lab approach.

Step 2: Selection: go / no-go decisions for experiments (Living Lab project team)
The ideas are translated into intake-forms and are evaluated by the Living Lab Project team, using a criteria framework including content match, level of innovativeness, practical and financial feasibility. If needed, advice can be asked from partners from the Bijlmer Bajes district, or the joint Innovation Board of BKO and AMS Institute. Any 'go' decision is seconded by approval of the BKO directors. For large scale experiments, high investment levels or large construction-relevant interventions, a formal approval is also required from the BKO advisory board. BKO is owner of the Green Tower premises and therefore responsible for its maintenance, safety, infrastructure, etc. Therefore, they have a final say in approving experiments in the Living Labs.

Step 3: Development: from idea towards experiment plan
The approved idea will now be developed into a realistic plan for the implementation, the Experiment plan. This also needs to be approved by the Living Lab project team.

Step 4: Contracting: from experimentation plan to user agreement
When the Experiment plan has been approved, a user agreement will be formulated between the experiment 'owner' and the Living Lab project team, and co-signed by BKO.

Step 5: Implementation: from user agreement to practice
After the sign-off, implementation can start. The building coordinator of BKO will oversee the implementation. Any responsibility is covered by BKO, not the Living Lab project team (as the latter is not a legal entity). The experiment and its progress will be regularly communicated publicly via the Green Tower Living Lab website. Information about the Experiment will also be made available onsite. The experiment will be regularly monitored with the Living Lab project team.

Step 6: Evaluation and scale-up: from practice to follow-up
Upon (near) completion of the experiment, it will be evaluated between the experiment 'owner' and the Living Lab project team, using a standardized Evaluation form. Points of attention are the more technical aspects of the experiment, but also the way of working and collaboration with various stakeholders. Potential scale-up is also discussed: is the experiment suitable for a follow-up within Green Tower? Could it be transferred to another site within the Amsterdam area or other cities? Based on the evaluation findings, new ideas can be submitted for developing next stages of the experiment, and the cycle starts again.

Examples of experiment ideas include the following:
- How to create an urban vertical park that contributes to a healthy living environment for the inhabitants of

Bijlmer Bajes Kwartier? What vegetation can be used and how are these maintained? How do inhabitants use and interact with the vertical park?
- Can we recover/convert nutrients and resources from waste produced by the tower and the neighbourhood?
- How can vertical farming be part of the Green Tower? Can it provide food for the Green Tower restaurant? Or for the region? And how can the farm's heat be used as an integral part of the energy- and/or heating system?
- Can we test and experiment with biobased, circular, energy generating or other innovative façade systems at the Green Tower?

The stepwise approach provides a procedure to assist experiment owners within the Green Tower Living Lab, as well as the challenge owners in general, with evaluating aspects of circularity and how to create the largest impact on the city level.

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